GAUGE THEORY AND COMPLEX GEOMETRY

Jørgen Ellegaard Andersen:
Title: The Verlinde formula for Higgs bundles
Abstract: In this talk we will present a Verlinde formula for the quantization of the Higgs bundle moduli spaces and stacks for any simple and simply-connected group. We further present a Verlinde formula for the quantization of parabolic Higgs bundle moduli spaces and stacks. We will explain how all these dimensions fit into a one parameter family of 2D TQFT's, encoded in a one parameter family of Frobenius algebras, which we will construct.

Alexey Bondal:
Title: D-bar super connections and their characteristic classes
Abstract: We discuss various features of d-bar super connections on complex manifolds, both compact and non-compact. In particular, we will describe the derived categories of such super-connections. We also discuss a construction of characteristic classes for dbar super-connections.

Peter Bouwknegt:
Title: Lie algebroid gauge theories and applications to T-duality
Abstract: In this talk I will discuss the gauging of a quantum field theory with respect to a Lie algebroid symmetry. In particular, I will discuss the gauging of 2D sigma models with respect to a (possibly non-isometric) Lie algebroid symmetry and applications to T-duality.

Benoit Charbonneau:
Title: Monopoles with arbitrary symmetry breaking
Abstract: Of monopoles with maximal symmetry breaking, we know a significant amount of information: spectral curves, rational maps, Nahm data. If the Higgs field is allowed to have equal eigenvalues at infinity there is less symmetry breaking, and surprisingly little is known. In joint work with Ákos Nagy (Duke), we study $\mathrm{SU}(n)$-monopoles with such arbitrary symmetry breaking, and their Nahm transform

Laura Fredrickson:
Title: The ends of the Hitchin moduli space
Abstract: Hitchin's equations are a system of gauge theoretic equations on a Riemann surface that are of interest in many areas including representation theory, Teichmüller theory, and the geometric Langlands correspondence. In this talk, I'll describe what solutions of $\mathrm{SL}(n,\mathbb{C})$-Hitchin's equations "near the ends" of the moduli space look like, and the resulting compactification of the Hitchin moduli space. Wild Hitchin moduli spaces are an important ingredient in this construction. This construction generalizes Mazzeo-Swoboda-Weiss-Witt's construction of $\mathrm{SL}(2,\mathbb{C})$-solutions of Hitchin's equations where the Higgs field is "simple."

Mario García-Fernández:
Title: Canonical metrics on holomorphic Courant algebroids
Abstract: Yau's solution of the Calabi Conjecture implies that every Kähler Calabi-Yau manifold X admits a metric with holonomy contained in $\mathrm{SU}(n)$, and that these metrics are parametrized by the positive cone in $H^2(X, \mathbb{R})$. In this talk I will give evidence of an extension of Yau's theorem to non-Kähler manifolds, where X is replaced by a compact complex manifold with vanishing first Chern class endowed with a holomorphic Courant algebroid. The equations that define our notion of "best metric" are motivated by generalized geometry, and correspond to a mild generalization of the Hull-Strominger system. Joint work with R. Rubio, C. Shahbazi and C. Tipler, `arXiv:1803.01873`.

Victoria Hoskins:
Title: On the motive of the stack of vector bundles on a curve
Abstract: Following Grothendieck's vision that a motive of an algebraic variety should capture many of its cohomological invariants, Voevodsky introduced a triangulated category of motives which partially realises this idea. After describing some of the properties of this category, I explain how to define the motive of certain algebraic stacks. I will then focus on defining and studying the motive of the moduli stack of vector bundles on a smooth projective curve and show that this motive can be described in terms of the motive of this curve and its symmetric powers. If there is time, I will give a conjectural formula for this motive, and explain how this follows from a conjecture on the intersection theory of certain Quot schemes. This is joint work with Simon Pepin Lehalleur.

Adam Jacob:
Title: Adiabatic limits of Yang-Mills connections on collapsing K3 surfaces
Abstract: In this talk I will discuss the vector bundle analogue of a degeneration problem considered by Gross-WIlson (and later Gross-Tosatti-Zhang). Namely, given an elliptically fibered K3 surface equipped with complex vector bundle, what are the convergence properties of a family of Yang- Mills connections on the bundle as the elliptic fibers collapse? I will demonstrate that when restricted to each fiber the connections converge to a flat connection uniquely determined by the holomorphic structure, and discuss progress towards convergence away from a finite number of singular points. This is joint work with Ved Datar and Yuguang Zhang.

Emmanuel Letellier:
Title: Cohomology of character varieties
Abstract: The computation of the cohomology of generic character varieties/moduli space of Higgs bundles started in 1987 with the work of Hitchin. In this talk I will review a conjectural formula for the mixed Hodge polynomial of character varieties and give various evidences including the recent computation of the Poincaré polynomial of character varieties by O. Schiffmann in the non-puncture case (2014), and by A. Mellit in the parabolic case (2017).

Laurent Manivel:
Title: Orbital degeneracy loci
Abstract : Orbital degeneraci loci are generalizations of ordinary degeneracy loci for morphisms between vector bundles. They can be constructed in a very general setting, from G-principal bundles and G-subvarieties of G-varieties. A rich source of interesting examples is provided by G-modules with finitely many orbits, which

have been studied extensively. The Gorenstein orbit closures can be used to construct lots of new Fano and Calabi-Yau fourfolds, for example, as orbital degeneracy loci. (References: `arXiv:1704.01436` and `arXiv:1802.08430`, with Benedetti, Filippini and Tanturri.)

Claudio Meneses-Torres:
Title: Schottky bundle uniformization and Kähler structures of moduli spaces
Abstract: Moduli spaces of stable vector bundles carry a natural Kähler structure, described originally in the Riemann surface case by Narasimhan and in the pioneering work of Atiyah-Bott. Such a Kähler structure is in many ways analogous to the Weil-Petersson metric on moduli spaces of Riemann surfaces, for which a deep relationship with the Liouville functional was discovered by Takhtajan and Zograf. In this talk I will describe work in progress on how the ideas of Takhtajan-Zograf can be adapted to vector bundles in three different settings: moduli of stable parabolic bundles in genus 0, moduli of semistable bundles in genus 1, and Jacobians. With the exception of the first case, the analogy follows as a consequence of the existence of Schottky bundle uniformizations, which remains an open problem for stable bundles in arbitrary genus.

Ruxandra Moraru:
Title: Moduli spaces of generalized holomorphic bundles
Abstract: Generalized holomorphic bundles are the analogues of holomorphic vector bundles in the generalized geometry setting. For some generalized complex structures, these bundles correspond to co-Higgs bundles, flat bundles or Poisson modules. I will give an overview of what is known about generalized holomorphic bundles, and describe their moduli spaces in some specific examples. Part of this is joint work with Shengda Hu and Mohamed El Alami, as well as Alejandra Vicente Colmenares and Vasile Brânzănescu.

Andrew Neitzke:
Title: On Hitchin's hyperkähler metric on moduli spaces of Higgs bundles
Abstract: I will review a conjecture (joint work with Davide Gaiotto and Greg Moore) which gives a description of the hyperkähler metric on the moduli space of Higgs bundles, and recent joint work with David Dumas which has given evidence that the conjecture is true in the case of SL(2)-Higgs bundles.

Christian Okonek:
Title: The gauged Landau-Ginzburg model of a Beauville-Donagi hyper-Kähler 4-fold
Abstract: This is a progress report on a joint project with A. Teleman, whose goal ist to describe the derived category of a Beauville-Donagi hyper-Kähler 4-fold. Let f be a general cubic form in 6 variables, $Z(f)$ the associated projective cubic hypersurface. The Beauville-Donagi hyper-Kähler 4-fold of f is the Fano variety $X(f)$ of lines in $Z(f)$; it admits a description by a linear Landau-Ginzburg model. I will explain a conjectural equivalence of the bounded derived category $D^b(X(f))$ of $X(f)$ with a purely algebraic category, the graded singularity category of a skew group algebra associated with the Sebastiani-Thom polynomial $f \boxplus f$. Our approach uses derived factorization categories of the Landau-Ginzburg model of $X(f)$ and $\mathbb{C}^*$-equivariant VGIT; it is motivated by a K-equivalence conjecture for certain Deligne-Mumford stacks. A second approach, using windows and equivariant matrix factorizations will be sketched, if time permits.

Du Pei:
Title: On mirror symmetry of (B, A, A)-branes
Abstract: Picking a real form G_r of a complex Lie group G defines a "(B, A, A)-brane" inside the moduli space of G-Higgs bundles. Under mirror symmetry, this (B, A, A)-brane will be mapped to a hyperholomorphic sheaf – a (B, B, B)-brane – over the moduli space of $G^\vee$- Higgs bundles, where $G^\vee$ is the Langlands dual group of G. In this talk, I will discuss how to construct these hyperholomorphic sheaves, and show how these proposals can be tested by computing equivariant indices. In particular, I will give computational evidence to Nigel Hitchin's proposal for the case of $G = \mathrm{GL}_2$ and $G_r = \mathrm{U}(1, 1)$. This talk is based on joint work with Tamas Hausel and Anton Mellit.

Francesco Sala:
Title: Cohomological Hall algebra of Higgs sheaves on a curve
Abstract: The main aim of the talk is to introduce an associative algebra structure, a la Hall, on the cohomology of the stack of Higgs bundles and sheaves (semistable or not, nilpotent or not) on a smooth projective complex curve X, and characterize it. Since Higgs sheaves on X correspond to torsion sheaves on the cotangent space of X, the above construction fits into a larger program which seeks to understand algebra structures associated with the algebraic stack of torsion sheaves on a smooth surface S. When the surface is the complex plane, and we restrict ourselves to zero-dimensional torsion sheaves, the corresponding algebra played a preeminent role in the proof of the Alday-Gaiotto-Tachikawa conjecture for supersymmetric gauge theories on the complex affine plane, given by Schiffmann and Vasserot. In the second part of the talk, I will explain a similar relation between my algebra and the AGT conjecture on ruled surfaces. This is a joint work with Olivier Schiffmann.

Florent Schaffhauser:
Title: Hitchin components for orbifold fundamental groups
Abstract: Let Y be a compact connected 2-orbifold of negative Euler characteristic and let π be its orbifold fundamental group. For $n > 1$, we denote by $\mathcal{R}(\pi, n)$ the space of representations of Π into $\mathrm{PGL}(n, \mathbb{R})$. The purpose of the talk is to show that $\mathcal{R}(\pi, n)$ possesses connected components homeomorphic to an open ball whose dimension we compute explicitly (for $n = 2$ and 3, we find again formulae due to Thurston and to Choi and Goldman, respectively). We then give applications of the result to the study of rigidity properties of hyperbolic Coxeter groups. This is joint work with Daniele Alessandrini and Gye-Seon Lee (University of Heidelberg).

Benjamin Sibley:
Title: A complex analytic structure on the compactification of Hermitian-Yang-Mills moduli space
Abstract: A key aspect of gauge theory is finding a suitable compactification for the moduli space instantons. For instantons on higher dimensional manifolds, Tian has defined a notion of instanton on manifolds posessing certain additional geometric structures, and made progress towards a compactification analogous to Uhlenbeck's compactification of the moduli space of anti-self-dual connections on a four-manifold. In the case when the base manifold is Kahler, and the bundle in question is hermitian, instantons which are unitary and give rise to a holomorphic structures are Hermitian-Yang-Mills connections. A sequence of such connections is known to bubble at most along a codimension 2 analytic subvariety, and so one might hope that there is a gauge theoretic compactification which has the structure of a complex analytic space. I will attempt to explain why this true in the case

when the base is projective. This gives a higher dimensional analogue of a theorem of Jun Li for algebraic surfaces. This is joint work in progress with Daniel Greb, Matei Toma, and Richard Wentworth.

Jeff Streets:
Title: Pluriclosed flow and geometrization of complex surfaces
Abstract: The pluriclosed flow is a natural extension of Kähler-Ricci flow into complex, non-Kähler geometry. In this talk I will describe various results which point towards a conjectural picture of the global existence and limiting behavior of the flow, in turn yielding a "geometrization conjecture" for complex surfaces. To finish I will describe the implications of this conjectural framework for understanding Class VII surfaces.

Jan Swoboda:
Title: The large scale geometry of the Higgs bundle moduli space
Abstract: In this talk I will explain recent joint work with Rafe Mazzeo, Hartmut Weiß and Frederik Witt on the asymptotics of the natural L^2-metric G_{L^2} on the moduli space $\mathcal{M}$ of rank-2 Higgs bundles over a Riemann surface Σ as given by the set of solutions to the so-called self-duality equations

$$\begin{cases} 0 = \bar{\partial}_A \Phi \\ 0 = F_A + [\Phi \wedge \Phi^*] \end{cases}$$

for a unitary connection A and a Higgs field Φ on Σ. I will show that on the regular part of the Hitchin fibration $(A, \Phi) \mapsto \det \Phi$ this metric is well-approximated by the semiflat metric G_{sf} coming from the completely integrable system on $\mathcal{M}$. This also reveals the asymptotically conic structure of G_{L^2}, with (generic) fibres of the above fibration being asymptotically flat tori. This result confirms some aspects of a more general conjectural picture made by Gaiotto, Moore and Neitzke. Its proof is based on a detailed understanding of the ends structure of $\mathcal{M}$. The analytic methods used there in addition yield a complete asymptotic expansion of the difference $G_{L^2} - G_{\mathrm{sf}}$ between the two metrics.

Szilard Szabo:
Title: Perversity equals weight for Painlevé systems
Abstract: We study the perverse Leray filtration induced by the Hitchin map on the cohomology spaces of the Dolbeault moduli space and the weight filtration on the cohomology spaces of the irregular character variety corresponding to each of the Painlevé $I - VI$ systems. We find that up to a shift the two filtrations agree, which provides further evidence to a conjecture of de Cataldo, Hausel and Migliorini.